REMARKS/ARGUMENTS

In view of the following remarks, Applicant respectfully requests reconsideration and allowance of the subject application. Claims 10 and 14-15 are amended and are in condition for allowance. This amendment is believed to be fully responsive to all issues raised in the 2/26/04 Office Action.

§102 REJECTIONS

Claims 10-15, and 17-19 stand rejected as being anticipated by Japanese Patent JP-A-H11-198387 to Fujikawa hereinafter referred to as "Fujikawa".

Claims 10-15 and 17-19

Claim 10 recites in pertinent part,

> A method of forming fluid handling slots in a semiconductor substrate having a thickness between opposing first and second surfaces comprising:
>
> - dry etching into the substrate from the first surface to form a first trench having a trench length and a trench width; and,
> - removing substrate material through the second surface to form a second trench, wherein at least a portion of the first and second trenches intersect to form a slot through the substrate, and wherein the slot has a maximum slot width measured parallel to the first surface that is less than one half of the thickness.

Claim 10 is amended with a clarifying amendment which overcomes the Fujikawa reference. Applicant respectfully requests the §102 rejection of claim 10 be withdrawn.

Claims 11-15 and 17-19 depend from amended claim 10 and as such recite features not disclosed by Fujikawa. Applicant respectfully requests the §102 rejection of claims 11-15 and 17-19 be withdrawn.

§103 REJECTIONS

Claim 4 stands rejected under §103 as being unpatentable over Japanese Patent JP-A-H11-198387 to Fujikawa hereinafter referred to as "Fujikawa" in view of US Patent No. 5,391,236 to Krut hereinafter referred to as "Krut".

Claim 4 recites a method of fabricating a slot in a print head substrate, comprising:

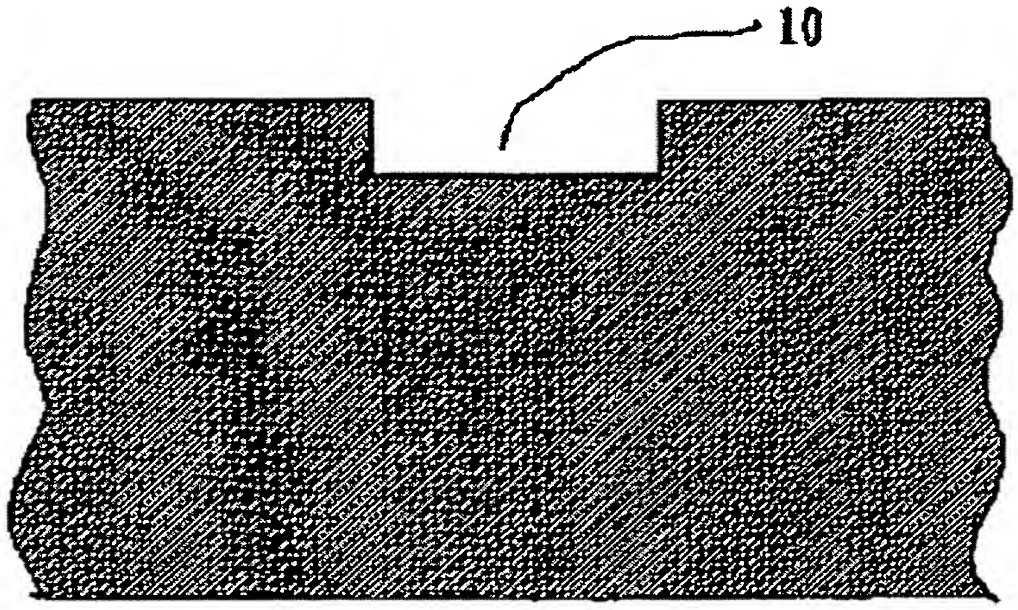
- dry etching through a first surface of the substrate having a thickness between the first and a second opposing surfaces, wherein said dry etching removes about 50 percent of the thickness of the substrate; and,
- sand drilling through the second surface of the substrate effective to form, in combination with said etching, a slot at least a portion of which passes entirely through the thickness of the substrate.

Fujikawa relates to a two step slotting method developed due to perceived deficiencies with traditional anisotropic slot forming techniques. Paragraph 8 relates to the problem to be solved by the invention and states "in the

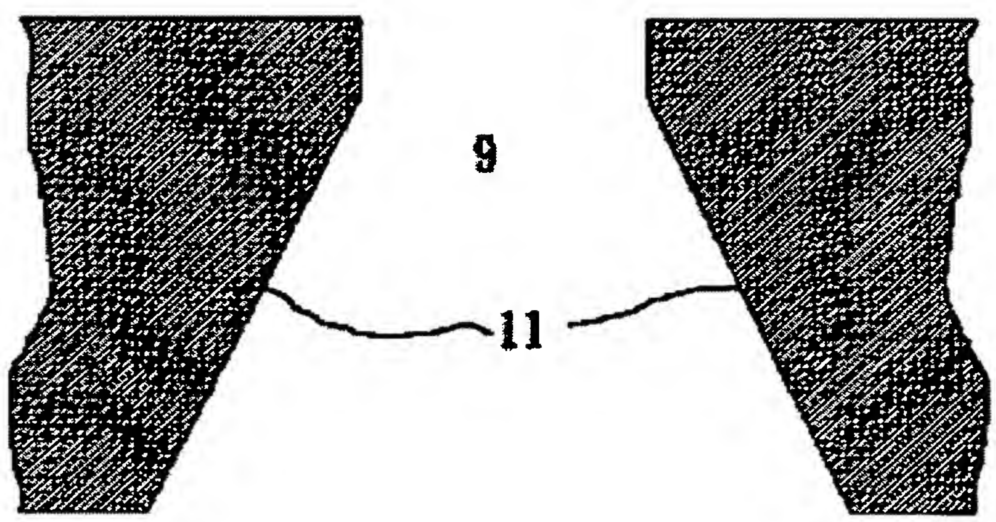
conventional method (of slot formation), the ink feed hopper 9 (or slot) is usually processed by anisotropic etching. Fujikawa goes on in paragraph 8 to state that "this anisotropic etching has risk of affecting the electrode wiring layer 4 and a nozzle wall" and that "the repeatability of processing is low and etches near the liquid route 8 side." Fujikawa continues in paragraph 8 and into paragraph 9 that variation in repeatability of such etches is inconsistent. Paragraph 9 continues that such inconsistent etching can produce inadequate or uneven fluid flow to the firing chambers and/or lead to damage to various components on the thin-film surface such as to the electrode wiring layer.

To overcome these shortcomings, Fujikawa describes etching a shallow precisely positioned trench in the thin film side of the substrate and utilizing a second removal process such as sandblasting from the opposite side of the substrate to intersect the trench to form a slot. This process avoids potential problems at the thin film surface and with associated thin film features.

(a)



(b)



The Office recognizes that Fujikawa does not disclose or teach "that the dry etching removes about 50% of the thickness of the substrate." The Office looks to Krut for suggestion to form such a limitation.

Krut involves electrically isolating individual photovoltaic cells contained on a wafer. To this end, Krut describes "a trench 12 that is relatively wide and shallow is formed on the front side of the substrate to provide for electrical

contact." Col. 3, lines 31-34. A narrower and deeper trench 14 is formed further into the bulk semiconductor from the floor of the outer trench 12 (FIG. 1c)." Col. 3, lines 39-41. "The trench 14 is used to provide electrical isolation between solar cells on either side, as described below." Col. 3, lines 47-49. "In the next step, illustrated in FIG. 1d, the inner trench and the adjacent portion of the outer trench are filled with an insulative filler material 16 that securely adheres to the substrate material on both sides." Col. 3, lines 50-53. The insulating filler is preferably a polyimide, which exhibits a strong adherence to the substrate, a good thermal match with semiconductor materials, thermal stability, and ease of processing. Other electrical insulators such as thick film glasses, acrylics, and adhesives could also be used. Col. 3, lines 53-59. Next, a third array of trenches 32 is saw cut in from the back of the substrate in alignment with the isolating trenches 14, to a depth at which they meet the lower ends of the isolating trenches. This establishes an air gap insulation between the lower portions of the adjacent solar cells 22 and 24, while the filler material insulates the upper portions of the two cells from each other. The back trenches 32 are preferably, but not necessarily, wider than the isolation trenches 14. The cutting operation to establish the third trenches 32 also cuts through the back electrode 10, dividing it into separate electrodes for each separate cell. Col. 4, lines 41-55. Krut then states that "except for the addition of front and back contact tabs for the terminal cells, the photovoltaic array is now complete. The filler material 16 provides a strong bond that securely holds the different cells

together, even when the lower trenches 32 are left open, without the need for any common substrate underlying the individual cells." As such, a slot is never formed through the substrate. Further, Krut states that the insulating filler preferably exhibits a strong adherence to the substrate. As such there is no contemplation of removing the insulative material to attempt to form a slot. The Office asserts that "Krut et al teach a method of forming a trench or slot or opening in a semiconductor substrate such as silicon, wherein the depth of the trench or opening is typically, roughly half of the substrate thickness (col. 3 lines 34-46)". However, the Office provides no source of motivation for applying Krut to the problems addressed in Fujikawa or even why a skilled artisan would consider Krut to be relevant to Fujikawa. At least for these reason there is no motivation to combine Fujikawa and Krut. As such Applicant respectfully requests withdrawal of the associated §103 rejection of claim 4.

Claim 4 stands rejected under §103 as being unpatentable over Japanese Patent JP-A-H11-198387 to Fujikawa hereinafter referred to as "Fujikawa" in view of US Patent No. 6,113,225 to Miyata hereinafter referred to as "Miyata".

Claim 4 recites a method of fabricating a slot in a print head substrate, comprising:

- dry etching through a first surface of the substrate having a thickness between the first and a second opposing surfaces, wherein said dry etching removes about 50 percent of the thickness of the substrate; and,

- sand drilling through the second surface of the substrate effective to form, in combination with said etching, a slot at least a portion of which passes entirely through the thickness of the substrate.

Fujikawa relates to a two step slotting method developed due to perceived deficiencies with traditional anisotropic slot forming techniques. Paragraph 8 relates to the problem to be solved by the invention and states "in the conventional method (of slot formation), the ink feed hopper 9 (or slot) is usually processed by anisotropic etching. Fujikawa goes on in paragraph 8 to state that "this anisotropic etching has risk of affecting the electrode wiring layer 4 and a nozzle wall" and that "the repeatability of processing is low and etches near the liquid route 8 side." Fujikawa continues in paragraph 8 and into paragraph 9 that variation in repeatability of such etches is inconsistent. Paragraph 9 continues that such inconsistent etching can produce inadequate or uneven fluid flow to the firing chambers and/or lead to damage to various components on the thin-film surface such as to the electrode wiring layer.

To overcome these shortcomings, Fujikawa describes etching a shallow precisely positioned trench in the thin film side of the substrate and utilizing a second removal process such as sandblasting from the opposite side of the substrate to intersect the trench to form a slot. This process avoids potential problems at the thin film surface and with associated thin film features.

The Office states that Fujikawa does not disclose or teach "that the dry etching removes about 50% of the thickness of the substrate." The Office looks to Miyata for suggestion to form such a slot.

Miyata teaches forming a feature in a substrate by etching the feature with a single etch step. See col. 11, lines 27-51. Miyata utilizes the very process that Fujikawa found unacceptable and in need of improvement. As such the references teach away from one another. Lacking a motivation to combine these references, Applicant requests that the associated §103 rejection be withdrawn.

Claim 21 stands rejected under §103 as being unpatentable over US Patent No. 6,312,612 to Sherman hereinafter referred to as "Sherman".

Claim 21 recites in pertinent part:

A method of forming slots in a semiconductor substrate having first and second opposing surfaces comprising:

- dry etching a first trench through the first surface of the substrate; and,
- creating a second trench through the second surface of the substrate effective to form, in combination with the first trench, a slot at least a portion of which passes entirely through the substrate, **wherein the maximum width of the slot is less than or equal to about 50 percent of the thickness of the substrate.**

Sherman describes a method of forming a microneedle array. Sherman teaches etching to remove material from a first surface of a substrate 410 to form

a bottom chamber configured to act as a fluid reservoir. “The bottom chamber formed by the sloped surfaces 452 and 454, in combination with the horizontal surfaces 450A and 450B, act as a small, recessed storage tank or chamber generally indicated by the reference numeral 470. This chamber 470 can be used to store a fluid, such as insulin, that is to be dispensed through the cylindrical opening 460 in the hollow microneedle 465. Col. 16 lines 32-37. In the illustrated embodiments, the fluid reservoir has a width approximately equivalent to the thickness of substrate 410 measured between the first and second surfaces. Material is subsequently removed form substrate 410 from a second opposite surface to create an outer surface of a microneedle. Further substrate material is removed to form a cylindrical opening 460 through the microneedle into the fluid reservoir. Sherman suggests that substrate 410 can “be made much larger in height so as to have a very large internal volume for holding a fluid substance”. Col. 16 lines 59-61. In such a situation the relative relationship of the fluid reservoir to the thickness of the substrate would remain constant.

The Office argues that changing the substrate thickness would affect the relative relationship between the fluid reservoir portion and the substrate thickness. Applicant respectfully argues that the relative relationship would remain essentially constant, while the volume of the fluid reservoir would increase with increasing substrate thickness. See Col. 16 lines 59-61. As such, Sherman teaches and suggests forming a microneedle through a substrate having a width that generally approximates the thickness of the substrate. Further,

Sherman contains no motivation to alter the relative relationship and instead teaches that the width of the structure provides a fluid reservoir and hence teaches away from narrowing the relative width of the microneedle relative to the substrate. Applicant respectfully requests that the §103 rejection of claim 21 based upon Sherman be withdrawn.

Claims 21-26 are rejected under §103 as being unpatentable over Japanese Patent JP-A-H11-198387 to Fujikawa hereinafter referred to as "Fujikawa" in view of US Patent No. 6,139,132 to Yasukawa hereinafter referred to as "Yasukawa".

Claim 21 recites in pertinent part:

A method of forming slots in a semiconductor substrate having first and second opposing surfaces comprising:

- dry etching a first trench through the first surface of the substrate; and,
- creating a second trench through the second surface of the substrate effective to form, in combination with the first trench, a slot at least a portion of which passes entirely through the substrate, **wherein the maximum width of the slot is less than or equal to about 50 percent of the thickness of the substrate.**

Fujikawa relates to a two step slotting method developed due to perceived deficiencies with traditional anisotropic slot forming techniques. Paragraph 8

relates to the problem to be solved by the invention and states "in the conventional method (of slot formation), the ink feed hopper 9 (or slot) is usually processed by anisotropic etching. Fujikawa goes on in paragraph 8 to state that "this anisotropic etching has risk of affecting the electrode wiring layer 4 and a nozzle wall" and that "the repeatability of processing is low and etches near the liquid route 8 side." Fujikawa continues in paragraph 8 and into paragraph 9 that variation in repeatability of such etches is inconsistent. Paragraph 9 continues that such inconsistent etching can produce inadequate or uneven fluid flow to the firing chambers and/or lead to damage to various components on the thin-film surface such as to the electrode wiring layer.

To overcome these shortcomings, Fujikawa describes etching a shallow precisely positioned trench in the thin film side of the substrate and utilizing a second removal process such as sandblasting from the opposite side of the substrate to intersect the trench rather than the thin film surface and associated thin film features. This technique utilizes the second substrate removal process to remove the majority of the substrate material as can be evidenced from Fujikawa Fig. 2 which is reproduced below.

The office recognizes that Fujikawa does not teach or suggest the limitations of claim 21 and looks to Yasukawa for these limitations. Yasukawa describes a substrate or spacer having a common ink chamber for feeding ink to multiple pressurizing chambers. Individual pressurizing chambers being associated with a nozzle. Yasukawa teaches achieving a desired feature

configuration by leveraging the relative etch rates within the substrate. Yasukawa states that "the common ink chamber 4 is required to have a large opening area for covering all of the pressurizing chambers 1 arranged in one row. Thus, the common ink chamber 4 is formed as a through hole by performing anisotropic etching on both faces of the silicon single-crystal substrate." Yasukawa, Col. 5 lines 33-37. Yasukawa continues that, "on the other hand, the nozzle communicating hole 6 for connecting the pressurizing chamber 1 to the nozzle opening 5 of the nozzle plate 7 is formed so as to elongate in a longitudinal direction of the pressurizing chamber 1 by full etching so that a length L1 required for passing through (L1 is the square root of 3 times or more as much as the thickness T1 of the silicon single-crystal substrate) is attained in the longitudinal direction of the pressurizing chamber 1, while suppressing the width W4 to be as small as possible. Yasukawa, Col. 5 lines 38-46.

The Office points to Col. 8 lines 1-28 of Yasukawa for suggesting utilizing the process of Fujikawa to create narrow slots. The Office points to the language regarding the width of the pressurizing chamber 41 as suggesting such a configuration. Applicant respectfully notes that the pressurizing chamber 41 which the Office defines as being equivalent to a slot is a blind feature as evidence in Figs. 7b and 8 which are reproduced below.

FIG. 7b

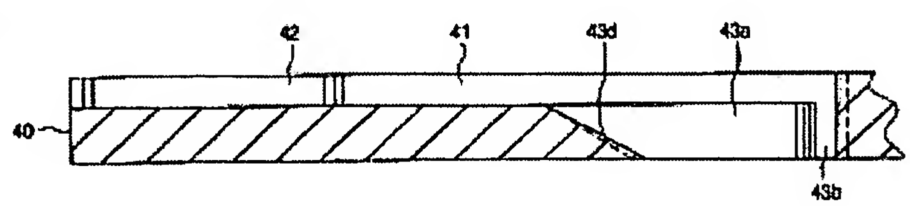
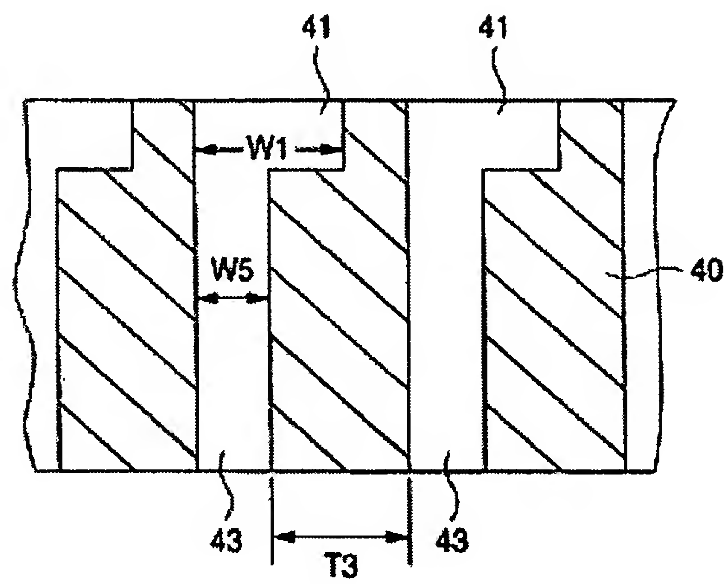


FIG. 8



Nozzle communicating hole 43 is a through hole and comprises a sloped portion 43d illustrated in Fig. 7b. Yasukawa teaches forming the nozzle communicating hole through the thickness of the substrate utilizing a single removal process- etching. See Fig 2. 4(I)-4(IV) and associated text. Fujikawa described such a process as problematic for various reasons including potential damage to various components positioned upon the substrate. See Fujikawa paragraph 9. Further, Yasukawa teaches forming the nozzle communicating hole with the substrate at a specific orientation such that the feature is formed into "the surface of the crystal orientation (110)". See Col 6 lines 45-47 and Col. 8 lines 1-17. Fujikawa found such etching processes problematic and cited among other reasons, inconsistent results. Applicant respectfully argues that there is no motivation to combine the teaching of Fujikawa and Yasukawa. On the contrary,

Yasukawa utilizing the very processes that Fujikawa described as unsatisfactory and as such teaches away from any motivation to combine the references. As such, one of skill in the art would not have been motivated to combine the two references.

The Office further states that one of skill in the art would be motivated "to combine Yasukawa teachings into Fujikawa's process for reasonable expectation of success by reducing the maximum width of the slot for preventing stagnation of air bubbles from the ink/fluid during the ink flow as taught by Yasukawa". Applicant also respectfully notes that Yasukawa Col. 8 lines 24-28 states "a slope 43d in which the nozzle opening side is placed down is formed so that the ink smoothly flows. As a result, it is possible to prevent stagnation of air bubbles caused by stagnation of ink from occurring." Applicant respectfully notes that slope 43d is associated with the length of nozzle communication hole 43 and has no relation to the width as suggested by the Office. See Fig. 7b reproduced above.

For at least these reasons, Applicant respectfully requests that the §103 rejection of claim 21 based upon Fujikawa and Yasukawa be withdrawn.

Claim 21 stands rejected under §103 as being unpatentable over Japanese Patent JP-A-H11-198387 to Fujikawa hereinafter referred to as "Fujikawa" in view of US Patent No. 6,143,190 to Yagi hereinafter referred to as "Yagi".

Claim 21 recites in pertinent part:

A method of forming slots in a semiconductor substrate having first and second opposing surfaces comprising:

- dry etching a first trench through the first surface of the substrate; and,
- creating a second trench through the second surface of the substrate effective to form, in combination with the first trench, a slot at least a portion of which passes entirely through the substrate, **wherein the maximum width of the slot is less than or equal to about 50 percent of the thickness of the substrate.**

Fujikawa relates to a two step slotting method developed due to perceived deficiencies with traditional anisotropic slot forming techniques. Paragraph 8 relates to the problem to be solved by the invention and states "in the conventional method (of slot formation), the ink feed hopper 9 (or slot) is usually processed by anisotropic etching. Fujikawa goes on in paragraph 8 to state that "this anisotropic etching has risk of affecting the electrode wiring layer 4 and a nozzle wall" and that "the repeatability of processing is low and etches near the liquid route 8 side." Fujikawa continues in paragraph 8 and into paragraph 9 that variation in repeatability of such etches is inconsistent. Paragraph 9 continues that such inconsistent etching can produce inadequate or uneven fluid flow to the firing chambers and/or lead to damage to various components on the thin-film surface such as to the electrode wiring layer.

To overcome these shortcomings, Fujikawa describes etching a shallow precisely positioned trench in the thin film side of the substrate and utilizing a second removal process such as sandblasting from the opposite side of the substrate to intersect the trench rather than the thin film surface and associated thin film features.

The Office recognizes that Fujikawa does not disclose or teach "that the maximum width of the slot is less than or equal to 50% of the thickness of the substrate." The Office looks to Yagi for suggestion to form such a slot. The Office refers to Col. 24 lines 8-19 as providing such teaching. Applicant respectfully asserts that the Office has misinterpreted the cited language from Yagi. Col. 24 lines 8-19 recite:

> After that, the silicon substrate was anisotropically etched from its back side so as to form an ink supplying hole used to supply ink. In the present embodiment, to make the dummy layer 15 and the ink supplying hole 225 have a desired width, <u>the widths of the masks used were set to 145 microns and 500-700 microns, respectively</u>. Note that these widths should be properly determined depending on a specific application and various parameters such as a silicon substrate thickness. The anisotropic etching described above was performed using an aqueous solution of TMAH at a solution temperature of 80 to 90.degree C. for an etching time of 15

to 20 hours for a silicon substrate with a thickness of about 625 microns (FIG. 22G).

The thickness of the substrate is 625 microns. Col 24, lines18-19. The masks which define the width of the feature at the first and second surfaces have widths of 145 microns and 500-700 microns. Col 24, lines 10-15. As such the slot will have a width at one surface which is approximately 145 microns and a width at the opposite surface that is 500-700 microns. Using the 500 micron value with the 625 micron thick substrate the maximum width of the slot is 80% of the thickness of the substrate. Therefore Yagi does not provide the limitations lacking in Fujikawa. Applicant respectfully requests that the §103 rejection of claim 21 based upon the combination of Fujikawa and Yagi be withdrawn.

<u>Provisional Double Patenting rejection/ §102/§103</u>

Applicant acknowledges the provisional double patenting rejection over a patent application to Rivas et al having Serial No. 10/061828 (hereinafter "Rivas"). Applicant confirms that the present application and Rivas were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person.

Conclusion

Claims 4, 10-19 and 21-26 are believed to be in condition for allowance. Applicant respectfully requests reconsideration and prompt issuance of the present application. Should any issue remain that prevents immediate issuance of the application, the Examiner is encouraged to contact the undersigned attorney to discuss the unresolved issue.

Respectfully Submitted,
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Dated: 5/26/04

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